Assessment of Photovoltaic Technology System Use in Doon School at Dehradun

By

Dr. Suneel Deambi

Tata Energy Research Institute
9 Jor Bagh
New Delhi - 110 003

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Content (SPV)

1.0 PV Technology (Introduction)

Photovoltaic technology deals with the direct conversion of incident solar energy into useful electricity. It has proved its capability to fulfil lighting needs and is particularly attractive for distantly located communities. Till now, more than 50,000 PV systems have been installed in different parts of the country and attend to diverse important requirements of lighting, water pumping, television, refrigeration and battery charging etc..

The option preferred is solar photovoltaics because of its inherent characteristics of being an omnipresent resource, modular and available in either small or large scale and reliable without any moving parts. Today, there is an impressive record of successful implementation of photovoltaics in the third world; hundreds of thousands of small PV systems are operated by the villagers in virtually all such countries. The use of photovoltaic systems is well established and proven.

Crystalline silicon cell technology comprising (single crystal + multicrystalline) silicon holds the key to the PV technology worldwide. There is, intensive research in progress in several prominent R&D laboratories to develop more cost effective cell materials with higher conversion efficiency levels. Silicon wafer is the basic substrate material, which is readied into a well developed cell structure. The PV system has as its essential elements - module, battery, luminaire and related electronics.

India possesses full domestic capability in silicon material development, cell and module manufacture and the Balance of System (BoS) manufacture. From the earlier use of automotive car batteries for PV applications, the more recent development is maintenance-free type lead acid batteries. Similarly, compact fluorescent lamps (CFL's) that are energy efficient are gradually replacing ordinary fluorescent tubelights in PV installations. Related electronics connected with the various PV systems is undergoing continuing development aimed at increasing performance reliability.

Amongst numerous PV applications in operation globally, those connected with lighting, water pumping and telecommunications are viable even at present day costs.

PV systems have been gifted by the Indian government to a large number of remote village communities under a large demonstrational programme. Emphasis is being placed also on the delivery of different kinds of PV systems on soft loan terms available from the Indian Renewable Energy Development Agency (IREDA). Both MNES and IREDA are actively encouraging entrepreneurship in this promising area of SPV. The recently initiated 1000 PV pump irrigation programme has had good initial success for its ability to draw large number of users from different regions of India.

Time is certainly appropriate for widening PV technology use through its installation in all possible places. The main feature of this clean source viz. PV is in its ability to meet power requirement in as small a size as required. Keeping in view the importance of encouraging adopting the environmentally benign technology specially in areas that have a very wide demonstration effect it seems very logical, if educational institutions such as the Doon School install PV systems of appropriate capacity. For an educational institution, it offers an important approach to familiarize students with this technology use by enabling experiments to be performed also apart from experiencing the high demonstrational value of abundantly available environmentally benign solar energy.

2.0 Objective of this Study (PV)

The essential aim of this study in the use of solar photovoltaic was to assess the scope for deployment of SPV systems in the Doon School primarily for lighting. The Doon school is possibly the most reputed Public School in the country with boys from every part of the country and some from overseas. Through an MOU with the CSIR the Doon School will be the Centre for Advanced Education in Schools in Science and Environment; the Centre will run the residential courses for science and environment secondary school teachers from all parts of the country and possibly from SAARC country also and will also encourage visits from school boys from all parts of the country. In this manner, the demonstration effect of the use of PV systems in the Doon School will be manifold.

3.0 Approach Followed

During the visit made to the Doon School in November 1993, a broad approach was adopted to evaluate the lighting requirement of each individual building. Several important considerations for possible PV system technology use were

borne in mind like for example the shadow factor, sunshine availability and more importantly, the degree of actual need.

Initially, extensive discussions were held with school officials who gave an overall view of the requirements, that could be fulfilled through PV. Subsequently, the entire campus was surveyed for on the spot assessment of critical needs that could be met through the use of PV systems.

Requirements were divided into following four main sections:

Indoor lighting
Outdoor lighting
Emergency lighting
Educational cum training aspects

A brief description of each is summarized.

3.1 Indoor lighting

In summary, the need identified for indoor lighting in the School relates to those which may be regarded as being of a somewhat vital nature. In this, particular category are included Bank and Accounts, Hospital, Houses (hostels for boys), Dining Hall, Physics Laboratory and the Art school. Indoor lighting requirements in other areas such as Squash Courts, Headmaster's Room are of a somewhat less critical nature. But it will suitable to include these places also while assessing the total number of indoor lighting units for installation of the PV systems, since the School area suffers from frequent power breakdowns and unreliable supply, which severely affects its operation.

Solar photovoltaic (SPV) systems intended to serve the indoor lighting needs typically comprise;

(a) SPV modules (single crystal silicon)
(b) Lighting assembly with inverter and PL-9 (compact fluorescent lamp) luminaire
(c) Battery
(d) Associated electronics

Compact fluorescent lamps are energy efficient and have a long operating life as compared to the ordinary tubelights. Hours of operation for this use have been taken as 2.

3.2 Outdoor lighting

A total of 8 outdoor PV lighting systems are needed to illuminate important paths during pitch dark conditions when normal electricity fails (which occurs frequently). There are many more points where such lighting units could be installed but for the shade. Outdoor lighting units essentially comprise TL-18 W luminaire, battery and related electronics. Functional hours for street lighting have been taken to be about 6 hours. PV system use for this purpose is based on time of requirement.

3.3 Emergency lighting

SPV lantern is a vital PV consumer product and has carved a separate niche for itself particularly in distantly located communities. It offers the added facility of mobile emergency use besides providing bright light (as compared to devices commonly used for such purpose in villages). During the time of electricity interruption in this School, these solar photovoltaic lanterns would be of great value in meeting lighting requirements. Moreover, this lantern can be carried to any location within the school campus. These lanterns could very well be utilized also for room lighting, when needed.

SPV lantern comprises of a low wattage compact fluorescent lamp (CFL), rechargeable Nickel-cadmium maintenance free battery, a 10 Wp module and the requisite electronics. During day time, the battery could be charged by exposing the PV module to the sun. It will be very suitable to employ a lantern for every room in the School, specially since it is a boarding school.

3.4 Education-cum training aspects

The Doon School being a premier educational institution in the country as well as the Centre for Advanced Education in Schools in Science and Environment will be the right place, where the benefits of PV technology (and use of solar energy) could be deeply inculcated in young minds. The School curriculum has undergone a sea change and can readily accept the students being given a proper understanding of this very technology.

Photovoltaic education device familiarly known as the PV education kit that is available today, is one such device which offers scope for training young boys in the school on the practical aspects of solar energy conversion. A demonstration of this product will have the following benefits for the student community.

(a) Serving proof of PV technology use
(b) Education-cum-awareness
(c) Working experience on the device through performing simple experiments

This novel education kit consists of a mini PV module, Nickel cadmium battery, couple of meters especially for the measurement of voltage (V) and current (I) etc.. Transistor, alarm clock, musical buzzer, calculator and torch etc. could be incorporated as optional experimental loads in this kit. This kit fits into a suitcase and as such is quite convenient to carry wherever needed.

A set of preliminary experiments could be designed, which may relate the solar intensity to the voltage and current output parameters. Likewise, the operational hours etc. of loads could be monitored especially during low sunshine and cloudy days.

4.0 PV Lighting Requirements (as assessed)

Requirements for lighting systems exist in the following units of the Doon School:

1. Bank/Accounts
2. Hospital
3. Houses

4. Dining Hall
5. Physics Laboratory
6. Art School
7. HM's Room
8. Squash Courts (within the swimming pool building)
9. Outdoors

4.1 Systems

Indoor lighting systems intended for use in the above units should employ solar PV modules (single crystal silicon), light assembly with invertor, PL-9 (compact fluorescent lamp)/TL-18 W, battery and associated electronics.

4.2 Distribution pattern

Bank/Accounts	
No. of lights required	6 (Bank 2; Accounts 4)
Switching operation	Manual
Battery/electronics	May be placed in a corner of the Accounts Section
Modules	Roof mounted
Hospital	
No. of lights needed	6 (Ward Room 2; Doctors Room's one each; Dispensary 1; Corridor 1)
Switching	Manual
Battery/electronics	In-house
Modules	Roof mounted
Houses	
No. of lights required	192 (8 in each toy Study Room)

Switching	Manual (as per the need)
Battery/electronics	Within each house
Modules	Roof mounted
Dining Hall	
Total number of lights	22
Staff room	2 (one in each)
Kitchen	5
Service area	2
Main hall	12
Entrance	1
Switching	Manual (recommended for all the operations)
Battery/electronics	Within the Main Hall
Modules	Roof mounted
Physics Laboratory	
No. of lights	6
Laboratory	5
Inner room	1
Operation	Manual
Battery/electronics	May be placed in the main laboratory room
Hours of operation	2
Art School	
Total no. of lights	4
Main art room	3
Inner room	1

Battery/electronics	May be positioned in the main room or adjacent room
Hours of operation	2
Headmasters Room	
No. of lights	2
Placement of lights	In the main room
Hours of operation	2
Squash Courts	
No. of lights	32
Placement	In the Courts
Hours of operation	2
Battery/electronics	May be placed in one of the adjacent rooms
Outdoors	
No. of lights	8
Placement	At strategic points like Jaipur junction, Pavilion - Dining Hall junction and Rear Gate pathway
Hours of operation	6
Battery/electronics	With individual units (as in case of pole-mounted lights)

5.0 Cost Assessment

On the basis of the survey carried in the school campus, a total of 270 indoor and 8 outdoor lighting systems are needed with the following break-up:

(A)

Unit	**Total no. of lights**	**Hours of operation**	**Total cost (Rs) (Approx.)**
Bank/Accounts	06	2	30,000
Hospital	06	2	30,000
Houses	(32) x 6	2	9,60,000
Dining Hall	22	2	1,10,000
Physics Lab.	06	2	30,000
Art School	04	2	20,000
HM's Room	02	2	10,000
Squash Courts (within the swimming pool bldg)	(08) x 4	2	1,60,000
Outdoors	08	6	2,00,000
		Total cost	15,70,000

5.1 Other essential requirements

Considering the high academic stature of this School and the fact that it will be the network Centre for Advanced Education in Schools in Science and Environment providing residential courses for secondary school teachers from all parts of the country and possibly for SAARC countries in Science and Environment, it will be good to introduce students to the concepts of solar energy (in this case - solar photovoltaics) through two PV education kits. Simple experiments can be thus conducted by students. In addition to this, it will be useful to have about 20 SPV lanterns (to start off with) for emergency use during night time.

(B)

Product	**Per unit cost**	**Total cost (Rs.)**
PV Education Kit	(Rs. 7500) x 2	15,000
SPV Lantern	(Rs. 5000) x 20	1,00,000
		1,15,000

Total cost (A+B) = **Rs. 16,85,000**
(in approximate terms)

6.0 Conclusions

Photovoltaic technology use in the Doon School through the installation of lighting systems etc. will definitely have manifold benefits. Students and Teachers of this school and from schools all over the country will attend residential courses in the school (which will be the National Centre for Advanced Education in Schools in Science and Environment in close association with the CSIR). This Centre will be greatly influenced by the demonstration benefits of PV technology and its application. This campus should be developed into a model renewable energy complex and especially used for demonstrational and training purposes. This will undeniably help expand the PV market. At a stage, when photovoltaic commercialization related efforts are being made vigorously in India, the adoption of PV systems by prominent educational institutions should be a welcome step important for Advanced Education in Schools. Therefore, all possible encouragement should be given to the Doon School to adopt comprehensive PV applications and so also create awareness amongst the young and among secondary school teachers from all parts of the country; and possibly from SAARC countries also.